Technical Report 1142

How Formal Training Affects Soldier Attitudes and Behaviors Towards Digitization

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14. ABSTRACT *(Maximum 200 words)*:

This research measured how formal training affects Soldier patterns of behavior and attitudes towards digitization. A set of questionnaires was administered to 24 enlistedSoldiers and 12 officers attending formal classroom training for the Force XXI Battle Command, Brigade and Below (FBCB2) digital system. One questionnaire was administered before training, and a second after training was complete. The questionnaires assessed Soldier opinions of FBCB2 usefulness and also their attitudes associated with using the system. Soldier responses before and after training were compared to assess how training affected their attitudes and behaviors towards digitization. Results showed Soldiers generally feel FBCB2 is useful and worth the additional effort required to learn the systems. It also indicated that formal training in digital systems has a significant positive effect on Soldiers' attitudes and behaviors towards digital systems. The results also seem to indicate that training may help Soldiers avoid maladaptive behavior patterns that have been identified in other areas. Behaviors such as disuse or over-reliance on automated systems, a significant problem in other areas, were relatively rare for Sddiers attending formal training.

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FOREWORD

Digital computer networks currently being procured and fielded by the U.S. Army have the potential to significantly improve the tactical performance of combat units. Digitization of the force promises to give everyone from commander to frontline Soldier a near perfect view of the battlefield, thus significantly reducing the proverbial "fog of war." Improved information flow makes it possible to quickly plan, coordinate, and execute operations at an increased operating tempo, so that tasks that once took hours now take minutes.

However, the promise of this new technology relies on its skilled application. Leaders and Soldiers must learn the best ways to apply digitization in order to gain the anticipated tactical advantages. Formal training in digital systems provides an essential foundation for this learning. Training provides digital system operators and leaders with the basic skills needed to employ digitization.

This report is part of a series aimed at identifying the best methods for measuring Soldiers' proficiency with digital technology. It measures how formal training affects Soldier patterns of behavior and attitudes towards digitization. The results of this investigation can be used to focus scarce training resources and time on those digital skills which have the greatest impact on unit performance.

The work described in this report is a portion of research task 234, Defining and Measuring Digital Skill Proficiency, sponsored by the Program Executive Office for Simulation, Training, and Instrumentation (PEOSTRI) Project Manager for Training Devices. The results of this work were briefed to III Corps' Battle Command Training Directorate at Fort Hood, Texas on 19 November, 2003.

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HOW FORMAL TRAINING AFFECTS SOLDIER ATTITUDES AND BEHAVIORS TOWARDS DIGITIZATION

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army's use of networked computer systems to enhance mission accomplishment, collectively known as digitization, has the potential to effect substantial improvements in how military operations are conducted. However, to capitalize on the benefits of digitization, units must invest considerable effort to train Soldiers in the skills they need to exploit the advantages of digital systems. Given that training time is often a scarce resource, it is important to understand how training affects outcomes. The present investigation explores how formal classroom training affects Soldiers' behaviors and attitudes towards digitization.

Procedure:

A set of questionnaires was administered to Soldiers attending formal classroom training for the Force XXI Battle Command, Brigade and Below (FBCB2) digital system. The participants were 24 enlisted Soldiers and 12 officers attending either FBCB2 Operator New Equipment Training (OPNET) or leader training. One questionnaire was administered before training began, and a second similar questionnaire after training was complete. The questionnaire assessed Soldiers' opinions of the usefulness and difficulties associated with using FBCB2, and also their attitudes associated with using the system. Soldier responses before and after training were compared to assess how training affected their attitudes and behaviors towards digitization.

Findings:

Soldiers generally feel FBCB2 is useful, and is worth the additional effort required to learn the system. They reported it is most useful for planning, preparation for combat, and movement, but less during combat (i.e. enemy contact). These phases (planning, preparation for combat, and movement) also were reported to entail the highest workload. Soldiers ranked the most useful planning capabilities as sending and receiving messages and overlays, and route planning. The non-planning related features ranked as most useful were sending and receiving messages, navigating to a location, checking the location of enemy units, and avoiding threats such as minefields. Overall, Soldiers reported that those features of FBCB2 which involved the highest workload and were most difficult to work with were also those rated the most useful. In addition, Soldiers' responses indicated they are unsure of the accuracy of FBCB2 elements, possibly because this topic is not covered in training.

Soldiers' responses after training were significantly different than before training for the majority of the topics covered in the class. However, topics not covered during the course showed little change from pre- to post training. Agreement among Soldiers about aspects of digitization was generally higher after training than before, although for some questions agreement was fairly low both before and after training.

The results also seem to indicate that training may help Soldiers avoid maladaptive behavior patterns which have been identified in other areas. Behaviors such as disuse or over-reliance on automated systems, a significant problem in other areas, were relatively rare in Soldiers attending formal training.

Utilization of Findings:

These findings can be used to show commanders the value of formal training over other training methods, such as on-the-job training or discovery learning. They show that formal training provides more benefits for Soldiers than simply learning to operate digital systems. Formal training affects Soldiers' willingness to employ digitization and may encourage them to use digital systems more.

The findings can also be used by trainers to decide what elements of digitization and digital systems are most difficult to learn and require the most training emphasis. In addition, since some of the questions asked Soldiers about the usability and workload associated with different digital tasks and tools, this information can be used by program managers to improve system usability.

HOW FORMAL TRAINING AFFECTS SOLDIER ATTITUDES AND BEHAVIORS TOWARDS DIGITIZATION

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HOW FORMAL TRAINING AFFECTS SOLDIER BEHAVIORS AND ATTITUDES TOWARDS DIGITIZATION

Introduction

This research investigates how Soldiers' attitudes and behaviors towards digital systems change as they undergo formal training. The effort had several objectives. The first was to determine how formal training affected Soldiers attitudes and behaviors towards digital systems, and also how it changed their use of the systems. The second was to identify what capabilities of digital systems, in this case the Force XXI Battle Command, Brigade and Below (FBCB2) Soldiers found more or less useful. The last objective was to identify if Soldiers exhibited certain maladaptive and adaptive behavior patterns towards digital systems which have been identified in other areas where users interact with automated systems. The effort did not assess training methods, rather, it measured the results of the training.

Before describing how this research was conducted, I will provide some background on U.S. Army digitization, how digitization is trained, and also discuss maladaptive and adaptive patterns of behavior towards automation.

Background

Digitization

In the U.S. Army, digitization consists of networked computer systems which are used to improve communication, mission planning, and integration among Battlefield Operating Systems (BOS). There are a number of digital systems, most of which are tailored to support a specific BOS, but which can share information with other systems (for a more detailed description of digitization, see Barnett, Meliza & McCluskey, 2001).

The digital system studied in this research was the FBCB2 system. FBCB2 is used by lower echelon (as the name implies, below brigade level) maneuver units both in Tactical Operations Centers (TOC) and in individual combat vehicles. In TOCs, FBCB2 is used to plan missions, send orders and battlefield graphics, and coordinate combat support functions. On vehicles, it is used to receive orders and graphics, plan routes and navigate to specific locations, as well as enhancing Soldier's situation awareness of the battle space. Most vehicles with FBCB2 are able to automatically report their position using onboard Global Positioning System (GPS) equipment. Thus, commanders and Soldiers can view the position of their vehicles and others in their unit in real time. An example of the FBCB2 display is shown in Figure 1.

Digitization Training

Formal training for digital systems is conducted at the Battle Command Training Center (BCTC) at Fort Hood, TX. BCTC provides Operator New Equipment Training (OPNET), leader training, and staff officer training for a number of different digital systems. OPNET for FBCB2 is normally approximately 40 hours of training conducted over five days; 36 hours of instruction with a four-hour practical examination. There are usually three instructors per class; one instructor presents the material while the other two assist students. The leader course is similar to OPNET training, but includes more tactical considerations.

The class normally consists of 20-25 Soldiers using desktop computers (training systems or "white boxes") with FBCB2 software. The computers are connected over a local area network (LAN) so that each classroom simulates an interconnected unit. For one 8-hour block of

instruction the students moved to another classroom to work with real FBCB2 hardware ("green boxes") to learn equipment inspection and pre-combat checks. The desktop computers use a mouse and keyboard for input, while the actual systems use a touch screen and track ball-like device. Although "white boxes" have different input methods than "green boxes," Soldiers report no problem switching between input devices.

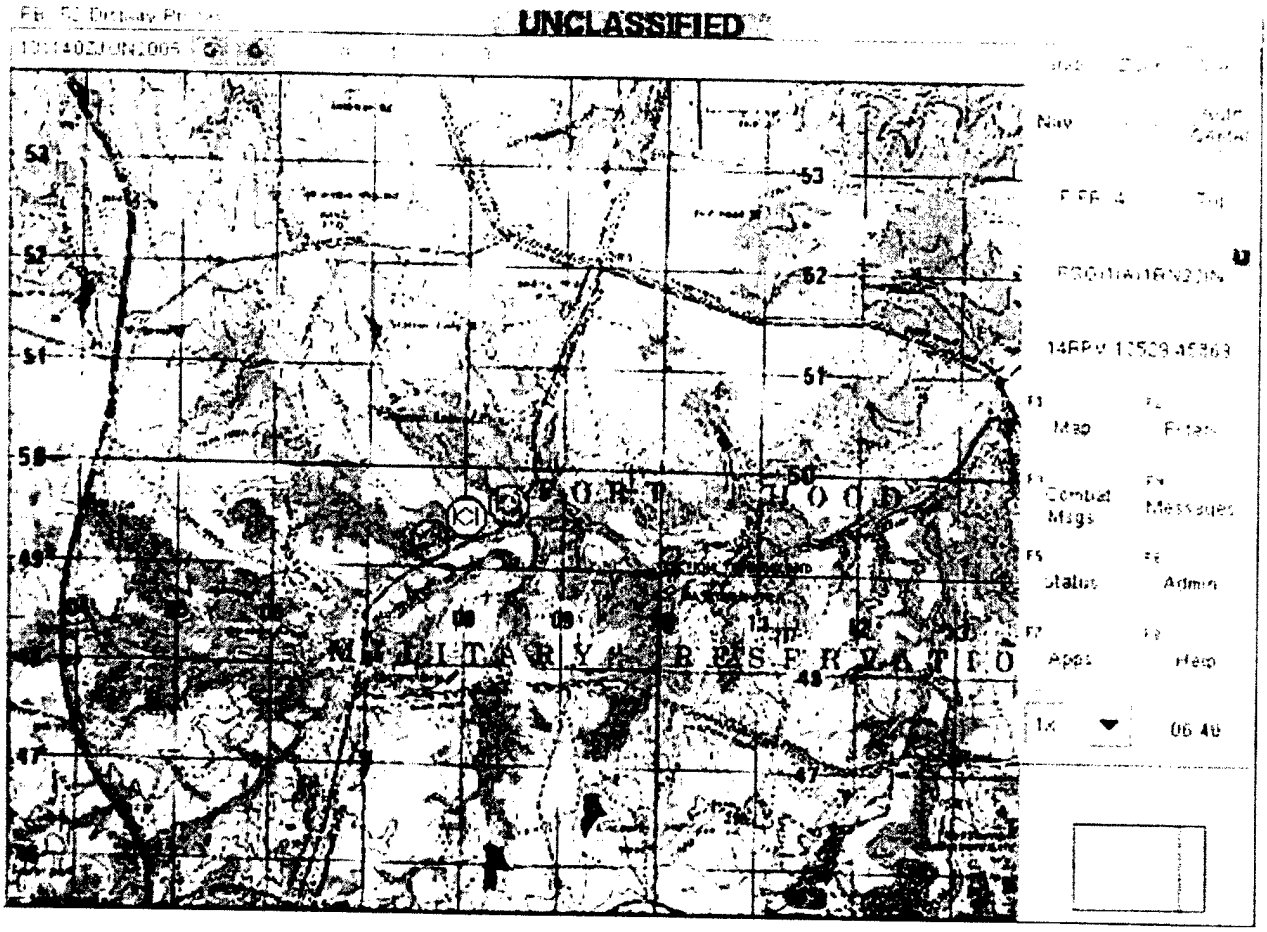


Figure 1. Example of Force XXI Battle Command Brigade and Below (FBCB2) display.

Most of the blocks of instruction are followed by a practical exercise where the students are able to practice what they learned. The blocks of instruction and exercises follow a natural progression including system startup, pre-combat checks, movement, assembly area operations, and actions on the objective. The training assumes the Soldiers have a basic tactical knowledge including familiarity with reports, map symbology, and battlefield graphics. It also assumes a basic knowledge of computer operation, such as using a computer mouse and keyboard, as well as familiarity with common desktop computer terminology. Previous experience with common desktop office software is helpful since the interface uses many conventions from office software, particularly the drawing tools used to draw battlefield graphics.

However, many Soldiers work with FBCB2 before they receive formal training because the formal training is often difficult to squeeze into the unit training schedule. They often learn about FBCB2 through on-the-job-training (OJT) or through a tutorial included with some of the

FBCB2 software. Thus, some of the Soldiers attending BCTC classes have digitization experience prior to classroom training.

Patterns of Behavior Towards Automation

Research has shown that people's attitudes and behaviors towards automation tend to form patterns. A decade of study in commercial aviation shows certain patterns in how people react to the introduction of automation into their work structure, and how they interact with the automated systems. Many of these behavior patterns interfere with the proper use of automation. Some users may avoid using automation all together, and thus lose the advantages automation offers. Conversely, other users may rely too much on automation, which often leads them into unpleasant or dangerous situations (Parasuraman & Riley, 1997). Similar patterns are beginning to show in other areas where automation has been introduced, such as surface transportation (Parasuraman & Riley, 1997) and medicine (Sheridan & Thompson, 1994).

Not surprisingly, initial studies and field observation seem to indicate Soldier's attitudes and behaviors towards digitization follow similar patterns. A recent study by Barnett & Meliza, (2003) showed concerns voiced by Soldiers about digitization, such as erosion of skills, system reliability, and increased workload, mirror concerns expressed by commercial air crews regarding automation.

If Soldier's behaviors towards digitization follow known patterns of behavior in relation to automation, this information can be useful in terms of integrating digitization into U.S. Army units. Commanders, trainers, and evaluators can use this knowledge to help them assess their unit's level of digital training and tailor training to be most effective.

Typical behavior patterns. A review of previous research and theory suggests that users seem to exhibit certain behavior patterns in response to working with automated systems (see Parasuraman & Riley, 1997). These patterns may reflect their attitudes towards automation, and may change as attitudes change. For example, people are often skeptical of automated systems at first, and will resist learning about them and avoid using them if they can. Others will use the systems, but only in a limited way. Sometimes people with more computer experience may actually rely too much on automation, which often causes its own set of problems. Conversely, other users rely on it in a more realistic way, possibly due to more experience or expertise with the systems.

Thus, the four patterns of behavior of interest in this research are:

- Avoidance or disuse behaviors
- Limited use behaviors
- Overuse or over-reliance behaviors
- Expert behaviors

In addition to the other research questions, the present research sought to identify if Soldiers exhibited any of these four behavior patterns. Previous field observations had identified disuse and limited use behavior patterns in some digital units. I wanted to see if Soldiers attending formal digitization training exhibited any of these behaviors, and, if so, how the formal training affected the behaviors.

Method

Participants

Participants were 36 Soldiers attending classes at the BCTC. The sample contained 24 enlisted Soldiers from Sergeant (E5) to Master Sergeant (E8), and 12 officers from Second Lieutenant (O1) to Major (O4). Soldiers below E5 were not selected to participate because it was felt their participation would take up too much class time. There was a wide range of Military Occupational Specialty (MOS) codes, indicating participants came from a diverse background. Tables 1 and 2 presents the list of MOS's.

Table 1. *List Of Enlisted Participants' MOS*

Enlisted MOS			
MOS Series	***Functional Area***	***MOS Series***	***Functional Area***
11B/M	Infantry	75H	Administration
12B	Engineering	77F	Petroleum
14S	Air Defense	79S	Recruiting
19K	Armor	88M	Transportation
44B 52C 63B/H/Z	Maintenance	95B	Military Police

Table 2. *List Of Officer Participants' MOS*

Officer MOS			
MOS Series	***Branch***	***MOS Series***	***Branch***
12A/C	Engineer	74A	Civil Affairs
14B	Air Defense	91A	Chemical Corps
25A	Signal Corps	92A/D	Ordinance
38A	Quartermaster		

For enlisted Soldiers, the range of years of service ranged from 2 years of service to over 20 years (M=11.6, SD=5.86). Officers' years of service ranged from less than a year to 22 years (M=7.77, SD=7.18).

Participant Computer Experience. When asked about experience with FBCB2 and general computer experience, enlisted Soldiers reported they had used FBCB2 for less than 12 months (M=1.46, SD=2.87) with many (15) reporting they have no experience with FBCB2. When asked how many hours a month they use FBCB2, most (16) reported they did not use it, while those that did averaged 2.6 hours a month (SD=5.34). Officers reported they used FBCB2 six months or less (M=1.1, SD=1.78), with the majority (7) reporting they had not used it yet. The distributions for all of these statistics were positively skewed, probably because of the large number who reported no FBCB2 use.

Participants were also asked how many hours a week they used computers at work and at home, and also how many hours they played computer games. Enlisted Soldiers reported they used computers at work an average of 15.3 hours a week (SD=18.8), and at home an average of 12.4 hours (SD=13.4). They also reported they played computer games an average of 3.7 hours a week (SD=7.67). Officers said they used computers at work an average of 22.5 hours a week (SD=16.7) and 12.8 hours at home (SD=9.7). Officers also said they played computer games an average of 4.5 hours a week (SD=5.7). Again, these statistics were positively skewed, which can

probably be attributed to the number of participants who reported no computer use at work or at home. Table 3 provides a comparison of how many hours a week Soldiers who responded to these questions use PCs at work, at home, and for gaming.

Table 3. *Hours per Week Respondents Use Personal Computers at Work, at Home, and Gaming*

Respondent	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hours/Work	60	48	40	40	30	25	25	20	15	10	10	10	8	6	0	0	0	0
Hours/Home	4	25	20	5	30	20	10	20	20	40	15	4	6	1	7	1	1	0
Hours/Gaming	1	3	15	2	15	0	10	0	3	30	4	0	14	0	1	1	1	0

A cross correlation matrix was constructed to identify relationships between participant demographics and both digital and general computer experience. Scatterplots showed the variables were not linearly related, thus Spearmans' Rho was chosen over the Pearson Product Moment Correlation. Significant correlations included a positive correlation between rank and hours of computer use at work ($r_s = .381$, $p.< .026$), a negative correlation between time in service and playing computer games ($r_s = -.447$, $p.< .008$), a high positive correlation between months of using FBCB2 and hours a week using FBCB2 ($r_s = .935$, $p.< .000$), and a positive correlation between home computer use and playing computer games ($r_s = .676$, $p.< .000$).

Materials

The materials consisted of a set of questionnaires, one administered pre- and one post-training. In addition to demographics, the questions were organized into four sections. The first section asked Soldiers questions about the usability, workload, and accuracy of FBCB2 and had them rank order a set of responses. The second section consisted of Likert-type questions that asked Soldiers to agree or disagree with statements related to typical behaviors towards automation. Section three asked questions about how Soldiers monitor digital systems and had Soldiers select from a series of responses. The last section asked several free response questions about system monitoring and about which tasks were the most difficult to perform.

The questionnaires also solicited demographic information as well as information on the individual's digital and general computer experience. Similar questions were asked before and after training. The order of questions on the post-training questionnaire was changed, and some of the questions were reworded to reduce the chance of the respondents being influenced by remembering the question from the pre-training questionnaire. The questions are discussed in the results section. Examples of the questionnaires are in Appendix B.

Procedure

The sets of questionnaires were distributed among the participants at the beginning of the classroom training. We decided that it would be too time consuming and disruptive of the class to collect the first questionnaire and then distribute the second questionnaire at the end of training. This would require the participants to remember participant numbers which would put an undue burden on both the participants and instructors. Therefore, we delivered both questionnaires in an envelope which was kept at the student workstation throughout the training. To ensure the questionnaires were completed in the correct order, they were clearly marked on the first page with instructions about the order of completion. In addition, the second questionnaire was printed on paper of a different color (yellow) than the first questionnaire

(white). The second questionnaire was also folded and sealed to further reduce the probability of Soldiers competing the questionnaires in the wrong order.

At the beginning of the class, participants were briefed on the purpose of the research and reminded that their participation was voluntary. Participants were then instructed to complete the first (white) questionnaire and return it to the envelope. After training was completed at the end of the week, they were instructed to remove the second (yellow) questionnaire, break the seal, complete the questionnaire, and return it to the envelope. The envelopes were then collected.

Both questionnaires and the envelope were identified by a participant number. Participants were briefed that they could mark their names on the envelope if they wished to prevent mix-ups but not to put their names on the questionnaires. Once the envelopes were returned, we separated the questionnaires from the envelopes to ensure participant anonymity.

Results

The questionnaire was in four sections, each soliciting information in different ways. Each of these sections will be discussed in turn.

Questionnaire Section One: Usefulness of FBCB2

The first section asked Soldiers questions about FBCB2 and had them rank order a set of responses. The questions sought to identify how Soldiers ranked the importance of aspects of FBCB2, and also how their view of the importance of these functions changed with training. Figure 2 shows an example of this type of question. The complete questionnaires are found in Appendix B.

1. What do you consider the most useful **planning** capabilities with FBCB2? Please rank order from most useful (number 1) to least useful

_____ Plan a route

_____ Plan support measures

_____ Send/receive messages/plans /overlays

_____ Line-of-sight tools

_____ Other _____

Figure 2. Example of question from section one of the questionnaire.

There are three questions I want to answer about this section; (1) how did Soldiers rank the statements, (2) how much agreement was there among the Soldier's ratings, and (3) was there a significant difference between how a statement was rated pre-test and post-test?

To answer the first question, I initially looked at the mode of the rankings of statements. Unfortunately, many of the statements were multi-modal with two and sometimes three statements receiving the same frequency of rankings. Therefore, I calculated the mean rank using Kendall's W test. Kendall's W, or Kendall's Coefficient of Concordance, determines the agreement among raters and, as a byproduct, calculates the mean rank of each statement. Mean rank is more descriptive than mode in this case because it avoids the problem of multiple modes and provides a better idea of how statements were rated by the population. Since the participants ranked the statements from 1 (highest rank) to k (lowest rank), statements with lower numbers were rated higher.

In addition, Kendall's W also answered our second question about how much agreement there was among the raters. Kendall's W statistic rates agreement as values from zero to one, with zero being no agreement among raters, to one being perfect agreement. The test for significance of the W statistic is a chi-square which determines how the calculated statistic differs from chance. (Siegel, 1956). The results of these analyses are discussed next.

Question 1. The first question asked, "What do you consider the most useful planning capabilities with FBCB2?" The response statements were, "Send/receive messages/plans/ overlays," "Plan a route," Line-of-sight tools," and "Plan support measures." The analysis of this question is summarized in Table 4, which shows the mode, mean rank, and Kendall's W for each statement both before and after training. The Soldiers generally ranked the usefulness of these capabilities as shown in the Table, except that "Plan support measures" got a higher rating than "Line-of-sight tools" on the pre-test, but was rated lower on the post-test. Kendall's W

showed there was moderately low agreement about the rankings on the pre-test, but agreement was much higher for the post-test. In both cases, the statistic differed significantly from chance and exceeded the $p<.05$ confidence level.

Table 4. *How Soldiers Ranked The Usefulness Of FBCB2 Planning Capabilities (Question 1)*

Statement [a]	Pre-training			Post-training		
	Mode	*M* Rank[b]	*W* [c]	Mode	*M* Rank	*W*
Send/receive messages/overlays	1	1.70	.247 (χ^2=20.0, df=3, p<.000)	1	1.47	.398 (χ^2=35.8, df=3, p<.000)
Plan a route	1	2.26		2	2.23	
Line-of-sight tools	4	3.07		4	3.10	
Plan support measures	3	2.96		1	3.20	

[a] Statements are listed in post-training rank order.
[b] Mean Rank from Kendall's *W* test.
[c] Kendall's Coefficient of Concordance (*W*).

Question 2. The second question was, "What do you consider the most useful FBCB2 capabilities other than planning?" and asked respondents to rank order statements from most useful (number one) to least useful. The statements are listed in Table 5, along with the analysis of the data. The Kendall's *W* shows there was little agreement among respondents either before or after training, although there was more agreement after training than before. The modes show the responses to be multi-modal, and there is little variance between the mean ranks, both of which probably reflect the lack of agreement among Soldiers as to the usefulness of FBCB2 capabilities.

Table 5. *How Soldiers Ranked The Usefulness Of FBCB2 Capabilities Other Than Planning (Question 2)*

Statement [a]	Pre-training			Post-training		
	Mode	*M* Rank[b]	*W* [c]	Mode	*M* Rank	*W*
Send/receive messages	3	4.11	.126 (χ^2=20.0, df=6, p<.002)	3	3.15	.203 (χ^2=36.5, df=6, p<.000)
Navigate to a location	4	3.83		1	3.27	
Check location of enemy units	2	3.52		1	3.47	
Avoid threats (minefields, etc.)	1	3.17		2	3.60	
Check location of subordinate unit	4	3.37		5	3.82	
Logistics/personnel reporting	7	5.28		6	4.97	
Check status of subordinate unit	7	4.72		7	5.73	

[a] Statements are listed in post-training rank order.
[b] Mean Rank from Kendall's *W* test.
[c] Kendall's Coefficient of Concordance (*W*).

One possibility for the lack of agreement is that the participants came from a variety of different backgrounds and therefore used FBCB2 for different purposes. There were 17 different MOS's among 36 participants, which is a clearly diverse group. This may account for them rating the usefulness of certain functions differently. To test this idea, I ran a Kendall's *W* on a select group of Soldiers with similar MOS's. I chose participants with infantry (11 series) and armor (19 series) MOS's since these Soldiers should use FBCB2 for similar purposes. Unfortunately, even by combining infantry and armor MOS's, the *n* was still too small to give a confidence interval better than $p<.05$. Thus this test gave us no useful information.

Question 3. This question asked Soldiers "When is FBCB2 most useful to you?" and provided a list of combat phases for them to rank order. The phases and analysis of the data are shown in Table 6. The table shows there was moderate agreement prior to training, but agreement was considerably higher post-training. Post-test modes and mean ranks show that Soldiers feel that FBCB2 is most useful during planning, preparation for combat, and movement phases, whereas it is least useful during assembly area operations and actions on the objective.

Table 6. *How Soldiers Ranked When FBCB2 Was Most Useful (Question 3)*

Statement [a]	Pre-training			Post-training		
	Mode	*M* Rank[b]	*W* [c]	Mode	*M* Rank	*W*
Planning	1	3.04	.230 (χ^2=38.5, df=6, p<.000)	1	2.17	.402 (χ^2=72.3, df=6, p<.000)
Preparation for combat	4	3.93		2	2.63	
Movement	1	2.29		3	2.93	
Attack	4	4.07		6	4.68	
Defense	6	4.57		4	4.90	
Assembly area operations	7	5.07		7	5.33	
Actions on the objective	7	5.04		7	5.35	

[a] Statements are listed in post-training rank order.
[b] Mean Rank from Kendall's *W* test.
[c] Kendall's Coefficient of Concordance (*W*).

Question 4. This question asked Soldiers, "When is FBCB2 workload the highest?" and provided the same list of combat phases as the previous question. The data analysis is summarized in Table 7. The analysis shows that rater agreement was fairly low both before and after training, although it did increase slightly after training. It is interesting to note that the rankings of combat phases for this question are roughly similar to the previous question which asked about when FBCB2 was most useful. Although the ranking for the first two phases in question 3 are reversed for question 4, the mode and mean rank statistics show these were very close in ranking. The similarity between the ranking of these phases suggests that when FBCB2 is most useful, it also has the highest workload.

Table 7. *How Soldiers Ranked When FBCB2 Workload Was The Highest (Question 4)*

Statement [a]	Pre-training			Post-training		
	Mode	*M* Rank[b]	*W* [c]	Mode	*M* Rank	*W*
Preparation for combat	3	3.77	.213 (χ^2=33.1, df=6, p<.000)	2	2.42	.260 (χ^2=40.5, df=6, p<.000)
Planning	1	2.81		1	2.62	
Movement	1	2.62		3	3.96	
Attack	6	4.04		4	4.23	
Defense	7	4.96		5	4.50	
Assembly area operations	7	4.92		7	5.12	
Actions on the objective	7	4.88		7	5.13	

[a] Statements are listed in post-training rank order.
[b] Mean Rank from Kendall's *W* test.
[c] Kendall's Coefficient of Concordance (*W*).

Question 5. The last question in this section asked, "On the FBCB2 display, which of the following is usually closest to ground truth (most accurate)?" The responses and the analysis of the data is shown in Table 8. For this question the *W* statistic for pre-training agreement does not meet the $p<.05$ confidence level. However, the post-training *W* statistic does provide sufficient confidence, and shows that even after training the agreement among Soldiers was low. This analysis suggests Soldiers are unsure about the accuracy of FBCB2.

Table 8. *How Soldiers Ranked The Accuracy Of FBCB2 Display Elements (Question 5)*

Statement [a]	Pre-training			Post-training		
	Mode	*M* Rank[b]	*W* [c]	Mode	*M* Rank	*W*
Friendly icons (center of mass)	3	3.19	.047 (χ^2=4.9, df=5, p<.423)	1	2.57	.161 (χ^2=16.9, df=5, p<.005)
Terrain features	1	3.48		1	3.05	
Friendly icons (individual platforms)	1	2.95		2	3.33	
Overlays	3	3.86		1	3.43	
Line-of-sight analysis	3	3.48		2	3.86	
Enemy icons	5	4.05		6	4.76	

[a] Statements are listed in post-training rank order.
[b] Mean Rank from Kendall's *W* test.
[c] Kendall's Coefficient of Concordance (*W*).

Differences after training. I also wanted to determine if Soldier ratings of usefulness, workload, and accuracy of FBCB2 changed after training. Therefore, for every question I compared how Soldiers ranked each item before training with the ranking they gave it after training using the Wilcoxon Signed Ranks test. The Wilcoxon Signed Ranks test is a nonparametric test which determines if a significant difference exists between matched pairs of scores using Z scores (Siegel, 1956). For all questions in this section I were interested in differences which exceeded the $p<.05$ confidence level (two-tailed).

Question one had no differences which exceeded the set confidence level. Question two asked which were the most useful FBCB2 capabilities other than planning. There were two responses which differed significantly; "Check status of subordinate units" ($Z=-2.45$, $p<.014$), and "Send/receive messages" ($Z= -2.21$, $p<.027$), both of which were ranked as less important after training.

Question three, which asked when FBCB2 was most useful also had two responses which were ranked differently after training. "Planning" ($Z= -2.58$, $p<.01$) and "preparation for combat" ($Z=-3.24$, $p<.001$) were both rated higher after training. Question four asked when FBCB2 workload was the highest. "Preparation for combat" ($Z=-3.12$, $p<.002$) increased in ranking after training, and "movement" ($Z=-3.34$, $p<.001$) decreased after training. Question five only had one statement which differed significantly. This question asked about the accuracy of display elements in FBCB2. Soldiers ranked "friendly icons (center of mass)" more highly after training than before ($Z=-2.56$, $p<.011$).

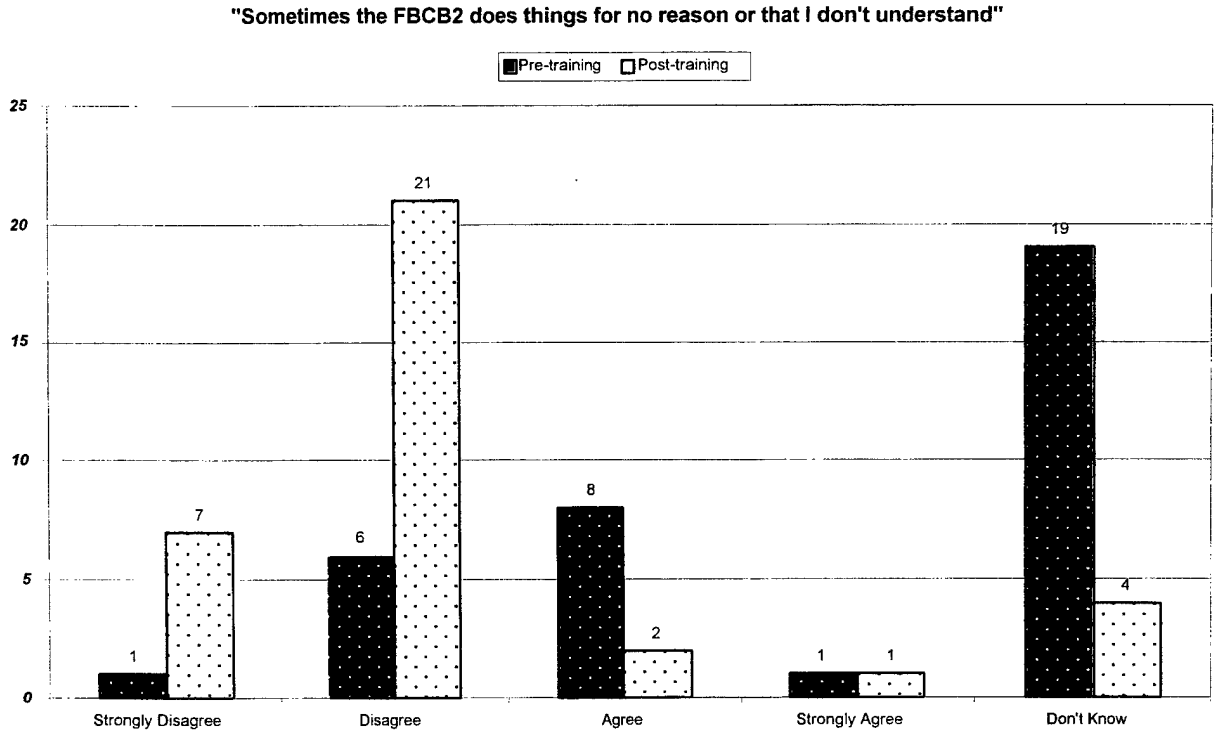
Questionnaire Section Two: Attitudes and Behaviors Towards FBCB2

The second section consisted of Likert-type questions that asked Soldiers to agree or disagree with statements. Soldiers were given nine statements and asked whether they strongly disagreed, disagreed, agreed, or strongly agreed with the statement. A fifth option was "Don't'

know." The nine questions were cross-correlated using Spearman's Rho to ensure there were no problems of singularity, that is, questions which measure the same construct (Tabachnick & Fidell, 1996). The highest correlation (r_s = .676, p.<.000) was between questions 7 ("FBCB2 really helps me do my job.") and 12 ("Even when it's not working perfectly, digitization is better than analog.") on the post-training questionnaire. Since none of the questions were highly correlated (.9 or greater) with each other, I assumed there was no singularity.

This section sought to identify Soldier attitudes and behaviors towards digitization and determine if they are similar to attitudes and behaviors reported towards automated systems in other areas. The behaviors of interest were avoidance or disuse behaviors, limited use behaviors, and overuse behaviors. For a discussion of use, disuse, and overuse of automation, see Parasuraman and Riley (1997). In addition, several of the questions sought to identify Soldiers who exhibited behaviors thought to show a deeper understanding of automation strengths and weaknesses (expert behaviors).

The first statement in this section was "Sometimes the FBCB2 does things for no reason or that I don't understand." This question seeks to measure disuse/avoidance behaviors, and it was expected that Soldiers who agree with this statement would tend to avoid using FBCB2. Figure 3 shows a bar graph comparing Soldier responses pre- and post-training. The dark bars



are pre-training responses and the light bars show post-training responses.

Figure 3. Comparison of frequencies of Soldier responses before and after training for statement 6, "Sometimes the FBCB2 does things for no reason or that I don't understand."

The figure shows that before training responses were fairly evenly split between agreement (56%) and disagreement (44%), and also that 20 out of 36 respondents answered

disagreeing with the statement. This suggests Soldier felt they had a better understanding of FBCB2 after training.

The next question directly assessed avoidance behaviors by stating "I don't use FBCB2 if I can avoid it." Figure 4 shows the responses to this statement before and after training.

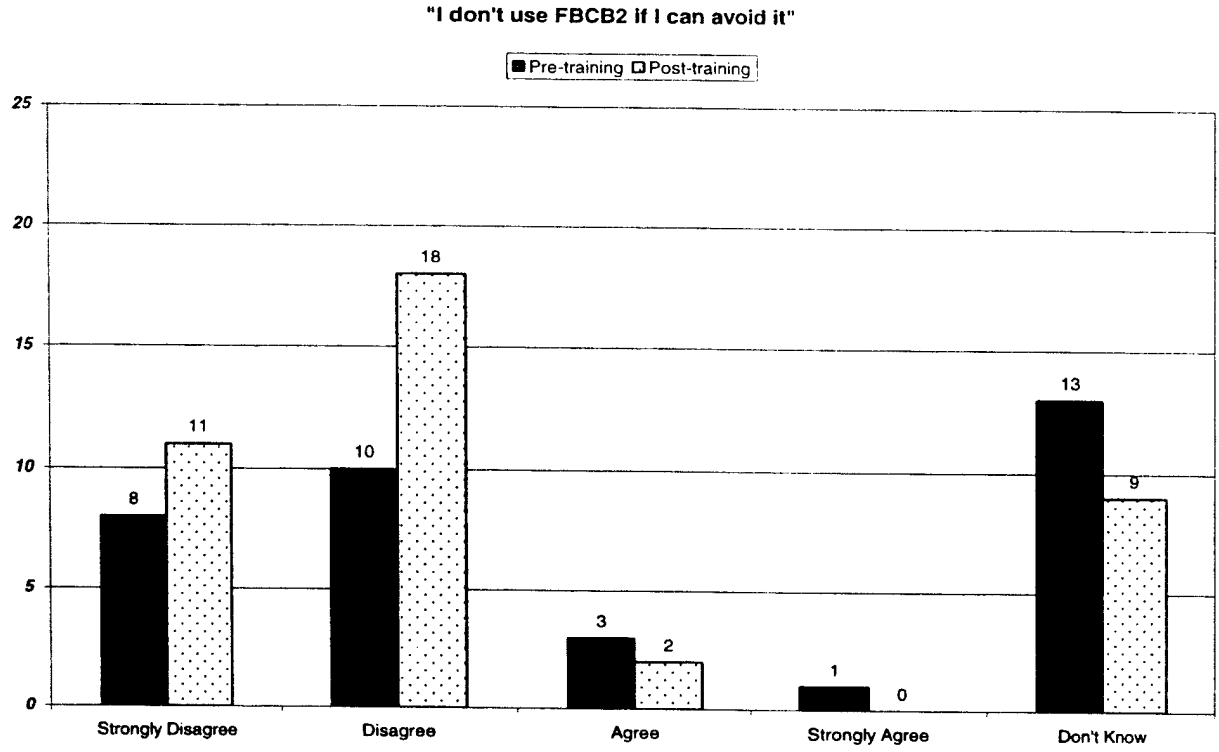


Figure 4. Comparison of frequencies of Soldier responses before and after training for statement 7, "I don't use FBCB2 if I can avoid it."

In this case, the figure shows most Soldiers disagree that they avoid using FBCB2 both before and after training. Before training, four Soldiers agreed (18% of those who responded) whereas 18 disagreed (82%) and 14 did not know or did not respond. After training, 29 disagreed (91%) and only 2 agreed (9%). A higher percentage of the Soldiers responded after training (29 out of 36, or 81%), versus before training (only 22 out of 36, or 61%).

The next statement was also designed to assess avoidance behaviors. The statement was "FBCB2 really helps me do my job." It was felt that Soldiers who avoided using FBCB2 would disagree with this statement. Figure 5 shows how Soldiers responded to this statement.

This figure shows the patterns of responses before and after training were roughly the same. A high percentage of Soldiers who responded agreed with the statement before (96%) and after training (93%). More Soldiers strongly agreed with the statement after training (3 before, 7 after), but also one more Soldier disagreed after training (1 before, 2 after).

The next statement was "FBCB2 isn't worth the amount of effort you have to put into it." This statement also sought to assess avoidance behaviors, and it was felt that Soldiers who agreed would probably avoid using FBCB2. Responses to this statement are shown in Figure 6.

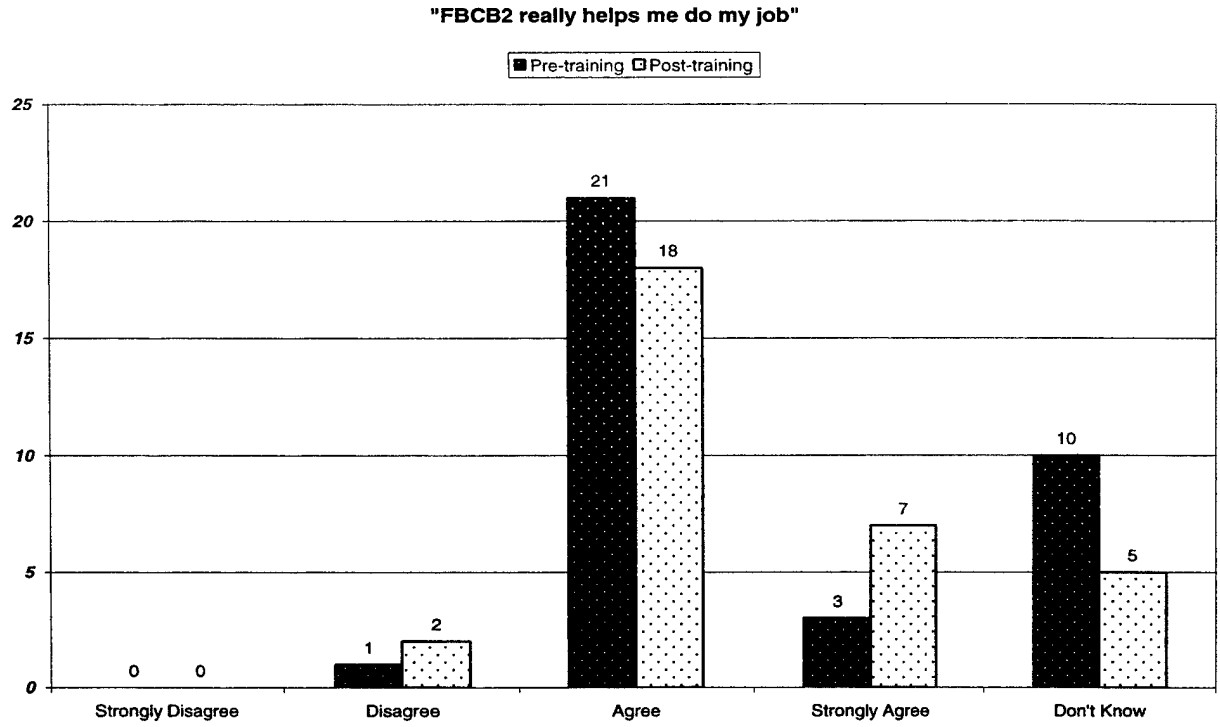


Figure 5. Comparison of frequencies of Soldier responses before and after training for statement 8, "FBCB2 really helps me do my job."

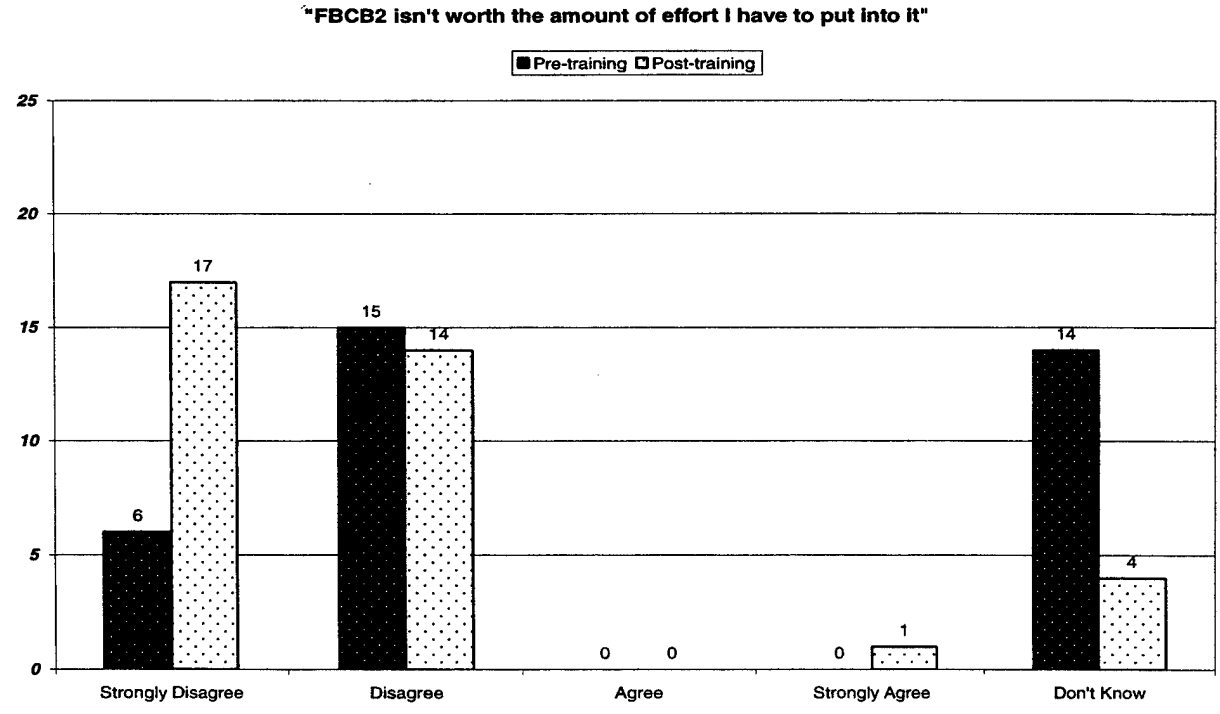


Figure 6. Comparison of frequencies of Soldier responses before and after training for statement 9, "FBCB2 isn't worth the amount of effort you have to put into it."

The figure shows that most Soldiers disagreed with this statement both before and after training. There were more "strongly disagree" statements after training, and fewer "don't know" statements.

Question 10 attempted to assess whether Soldiers used FBCB2 in a limited way. Research from other areas on automation use suggests some users employ a few automated tools, but do not learn the entire range of automated aids open to them. Soldiers were asked to respond to the statement "I only use FBCB2 to do a few things." The frequencies of responses to this question are shown in Figure 7.

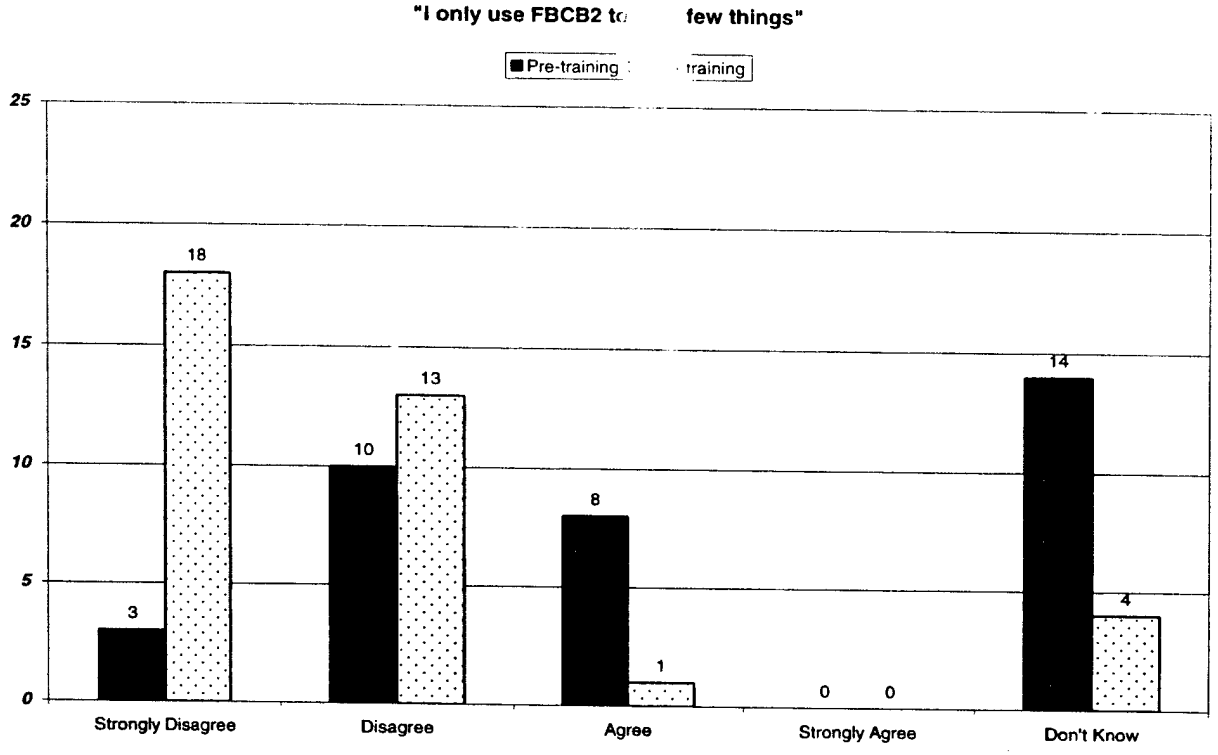


Figure 7. Comparison of frequencies of Soldier responses before and after training for statement 10, "I only use FBCB2 to do a few things."

The figure indicates that prior to training the majority of responses was "don't know" with the remaining responses leaning towards disagreement. However, after training the majority of responses (50%) strongly disagreed with the statement and another 36% disagreed. In fact, there was only one "agree" response.

The next several questions dealt with overuse behaviors. Sometimes users tend to trust automation too much (Sarter & Woods, 1997) or use it when manual procedures are easier or more appropriate (Parasuraman & Riley, 1997). Question 11 sought to assess how Soldiers viewed the accuracy of FBCB2 information. The statement was "I know the information I get from FBCB2 is correct." The intent of the statement was to suggest that information from FBCB2 is always correct. I believed that Soldiers who agreed with this statement would tend to place too much trust in the automated system, which has been referred to as "automation bias" (Mosier, Skitka, Heers, & Burdick, 1998). Figure 8 shows the responses to this statement.

As Figure 8 shows, most Soldiers were not sure about the accuracy of FBCB2 before training, although a number agreed that they "know" information from FBCB2 is correct. After training the majority of Soldiers disagreed that they "know" FBCB2 information is correct. This suggests the training may have given them a more realistic view of information accuracy, and consequently it may help Soldiers avoid automation bias.

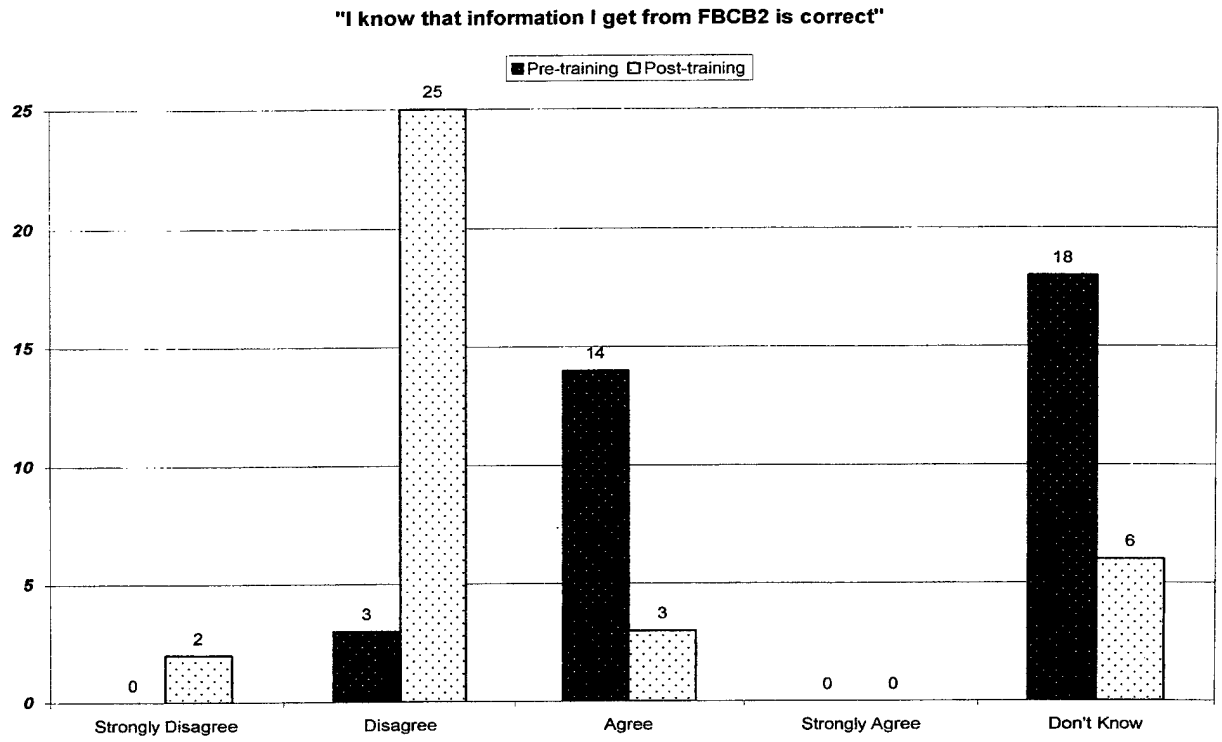


Figure 8. Comparison of frequencies of Soldier responses before and after training for statement 11, "I know the information I get from FBCB2 is correct."

Next, statement 12 was designed to identify between avoidance or disuse behaviors. The statement said, "If the FBCB2 isn't working right, it's best to try to get it working rather than revert to analog." I expected that Soldiers who disagreed would tend to avoid using digital systems, reasoning that manual (analog) is better and if the system isn't working they should immediately revert to manual. Originally, I had hoped this question would also identify overuse behaviors, since one of the typical behaviors of overuse is focusing on fixing a malfunctioning system at the expense of performing the immediate task (Parasuraman & Riley, 1997). However, I realized that Soldiers who did not tend towards overuse could also agree with the statement. The responses are shown in Figure 9.

The responses both before and after training are very similar, as shown in the figure. The main difference is fewer Soldiers chose the "don't know" response after training. Like other questions, it suggests Soldiers had a better idea of the parameters of the system after training and consequently expressed their opinion rather than choose "don't know." Most Soldiers (60%) agreed with the statement.

Statement 13 said, "FBCB2 is useful to do a lot of things, but I still check to make sure the information it gives is correct." Like statement 11 mentioned above, this statement was designed to identify overuse or automation bias behaviors. I expected that Soldiers who disagreed with the statement were biased in favor of automation and would show overconfidence behaviors. A bar graph of responses is shown in Figure 10.

The figure shows that the principle change from pre-training to post-training is fewer Soldiers chose the "don't know" response after training. The pattern of agreement is roughly the same, with most Soldier agreeing with the statement. Before training, 63% of those responding chose agree or strongly agree, while after training 80% chose these responses. However, on the other hand, after training 11% of the Soldiers chose to disagree with the statement. The results from this statement seem to suggest that after training Soldiers had a better idea of how far they could trust FBCB2 than before training.

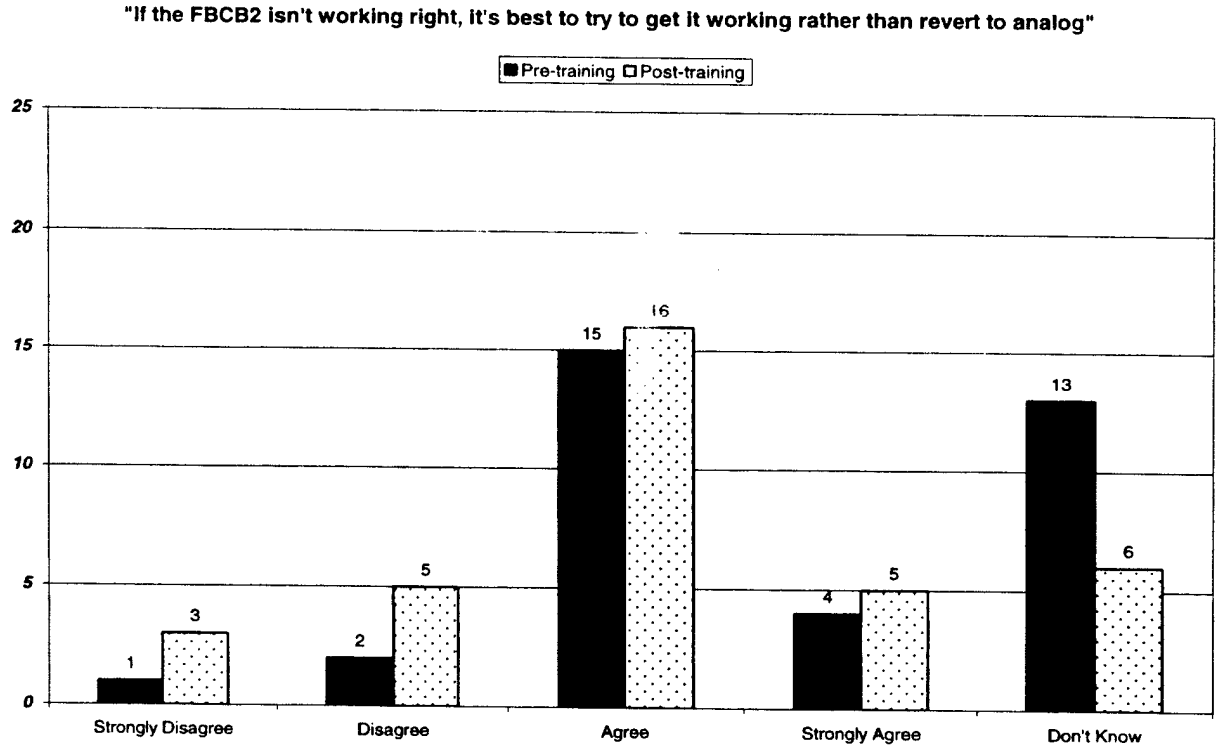


Figure 9. Comparison of frequencies of Soldier responses before and after training for statement 12, "If the FBCB2 isn't working right, it's best to try to get it working rather than revert to analog."

The last statement was designed to measure Soldier's overall level of expertise with FBCB2 and digitization in general. It is based on the idea that experts prefer shortcuts and use more abbreviated procedures (Eberts, 1994) and when none are available they may develop their own. The statement was, "Sometimes there are easier ways to do things than what's taught in class or shown in the book." Responses to this statement are shown in Figure 11. As the figure shows, before training most of the Soldiers (83%) chose neither to agree or disagree. After training, they were fairly evenly split between agreement and disagreement.

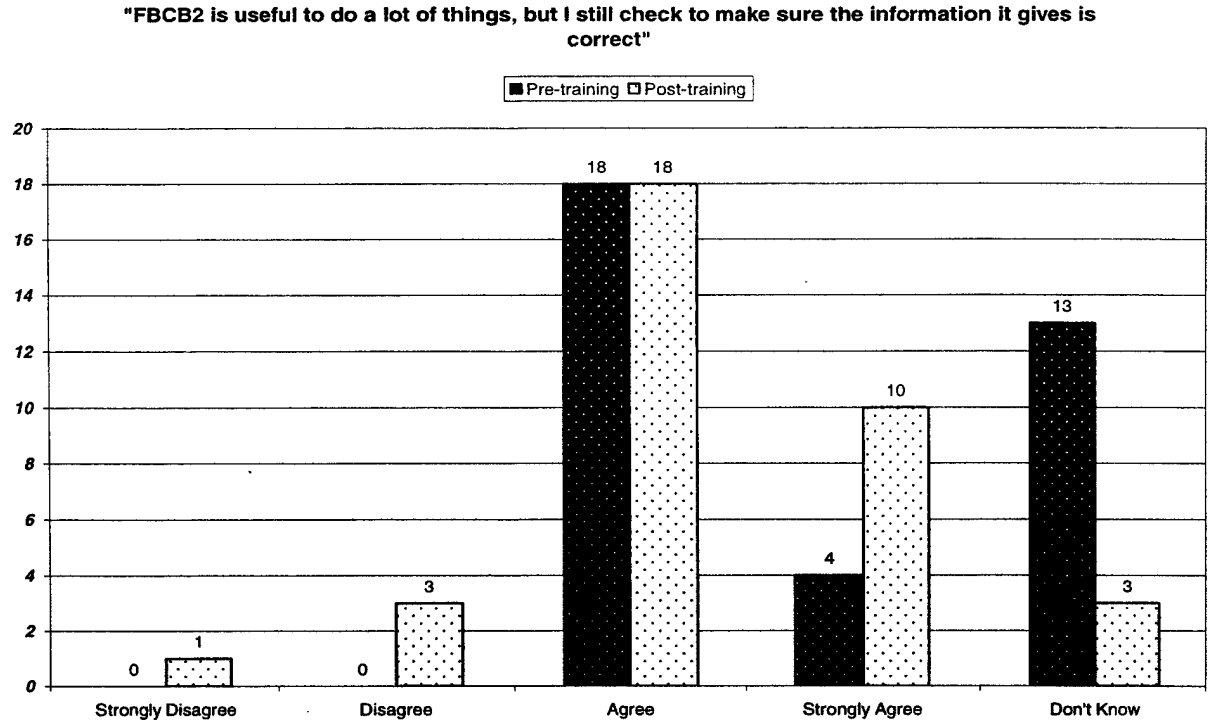


Figure 10. Comparison of frequencies of Soldier responses before and after training for statement 13, "FBCB2 is useful to do a lot of things, but I still check to make sure the information it gives is correct."

Differences between pre- and post-training ratings. To identify significant differences between pre- and post-training responses, a Wilcoxon signed-ranks test was performed for matched pairs. The Wilcoxon signed-ranks test measures the direction of differences between ratings of related pairs, but also considers the magnitude of the differences. Therefore, the Wilcoxon is a more powerful test than the Sign test (Siegel, 1956). Even so, response rates for this section were fairly low because some respondents either did not answer or chose the "don't know" response. In either case, these pairs of responses were eliminated from the analysis. This accounts for the low *n* of most of the statements in this section.

Two statements, 10 and 11, showed significant differences. Statement 10 "I only use FBCB2 to do a few things," showed significantly less agreement with the statement after training ($z = -3.22$, $p<.001$), which suggests Soldiers were willing to use FBCB2 for more tasks or use more of the tools, or both.

In addition, statement 11, "The information on FBCB2 is almost always correct, so I don't bother checking it," also showed significantly less agreement after training ($z = -3.464$, $p< .001$). This could mean that Soldiers had a better appreciation of the accuracy of digital information, or at least of the need to cross-check information. Since failing to cross-check information from automated systems is a behavior associated with over use or over reliance on automation, the training may reduce the chances of Soldiers engaging in these behaviors.

Statement six, "Sometimes the FBCB2 does things for no reason or that I don't understand," (see Figure 3) had relatively few usable responses ($n = 15$). The low *n* is primarily

a result of "don't know" responses which were not counted in this analysis. Although the results do not meet the error probability criteria of $p < .05$ ($z = -1.82$, *n.s.*), an examination of Figure 3 shows there were more disagreement responses after training than before, which suggested there may be a difference between pre- and post-training responses which is not evident, perhaps due to an intervening variable. Our search for this variable revealed that Soldiers who had previous FBCB2 experience responded differently from those with no previous experience. When I analyzed each of these groups independently, I found Soldiers with previous FBCB2 experience showed a significant difference in responses before and after training ($z = -2.43$, $p < .015$). These Soldiers reported they had a better understanding of FBCB2 after training.

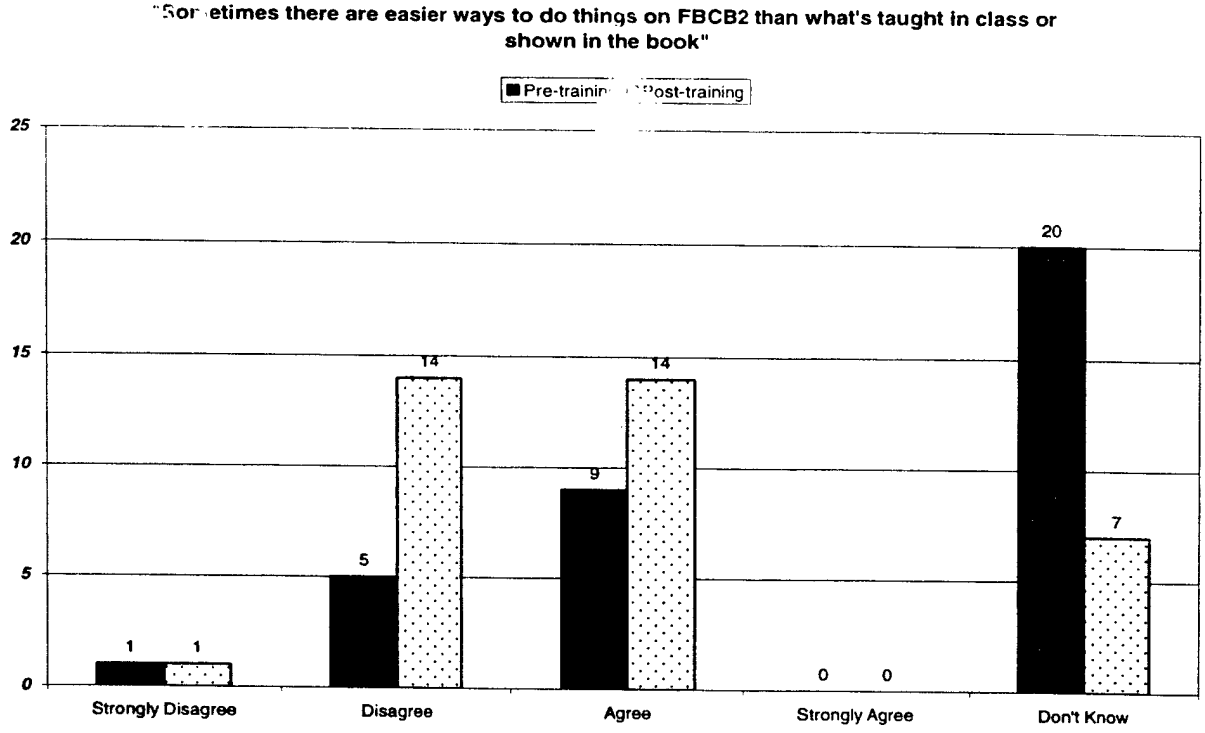


Figure 11. Comparison of frequencies of Soldier responses before and after training for statement 14, "Sometimes there are easier ways to do things than what's taught in class or shown in the book."

Statement 14, "Sometimes there are easier ways to do things on FBCB2 than what's taught in class or shown in the book" (see Figure 11), also has a low response rate ($n = 15$) and does not meet the .05 confidence level ($z = -1.63$, *n.s.*).

Questionnaire Section Three: FBCB2 Monitoring Behavior

Section three consisted of two questions. For each question Soldiers were asked to select from a series of responses. The first question was, "How often would you look at the FBCB2 display after you crossed the Line of Departure (LD)?" The purpose of this question was to gather data on how Soldiers employed the FBCB2 display during movement. The possible responses were (a) "Never," (b) "Every few minutes," (c) "Every few seconds," (d) "If I'm lost/confused or when approaching the next decision point," and (e) "Other." Soldiers responses are shown in Figure 12.

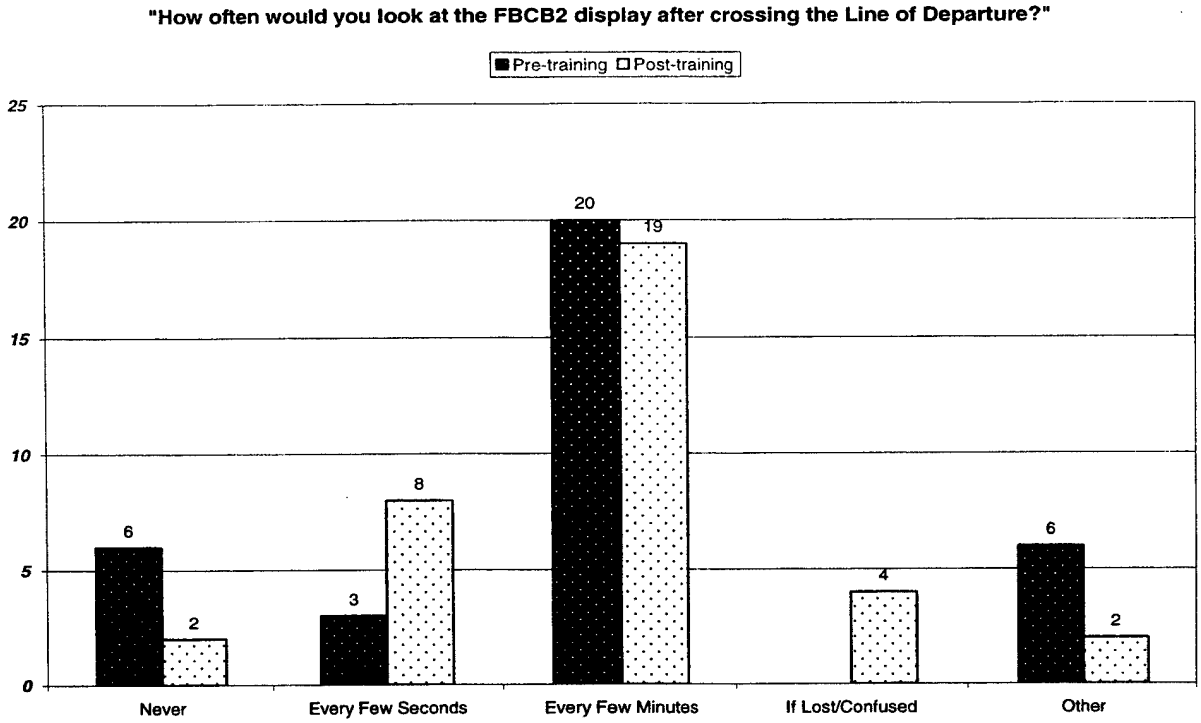


Figure 12. Comparison of frequencies of Soldier responses before and after training for question 15, "How often would you look at the FBCB2 display after you crossed the Line of Departure (LD)?"

The bar graph shows that the pattern of Soldier responses changed little from before to after training. Most Soldiers said they would check the FBCB2 display every few minutes after crossing the LD. After training, fewer Soldiers said they would never check the display, and more said they would check it every few seconds. Also, after training more Soldiers admitted they would check the display if they were lost or confused, or approaching a waypoint. There were also fewer "other" answers after training. Most of the Soldiers who marked "other" before training added that they didn't know how often they would monitor the display.

The second question in this section asked about sharing tasks with others, often known as "task shedding" (Sirevaag, Kramer, Wickens & Reisweber, 1993). Specifically, I wanted to know how Soldiers handled the requirement to monitor FBCB2. The question asked, "How often would you hand-off the requirement to monitor the FBCB2 display to someone else?" Soldiers could choose (a) "Never," (b) "If I'm doing something else," (c) "Every few minutes," (d) "Always," or (e) "Other." The responses to this question are shown in Figure 13.

Like the previous question, the pattern of responses was very similar both before and after training. Most Soldiers agreed they would delegate the monitoring task if they were involved with another task. A few Soldiers before training said they would "always" delegate FBCB2 monitoring, whereas after training no one chose this response. The "other" responses after training mostly fell into the "Don't know," or "Depends on the situation" category.

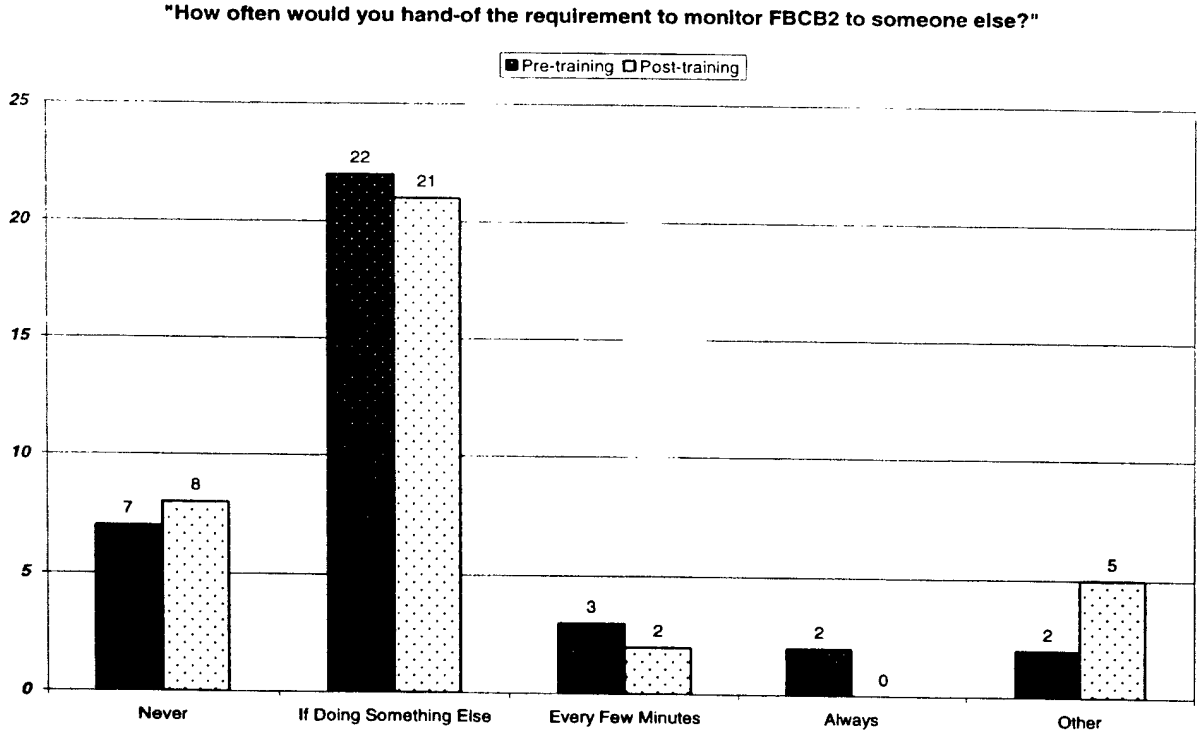


Figure 13. Comparison of frequencies of Soldier responses before and after training for question 16,"How often would you hand-off the requirement to monitor the FBCB2 display to someone else?"

Pre- post-training differences. I also wanted to know how many Soldiers changed their answers after training, and if so, if the changes formed a pattern. To answer these questions, I examined Soldier responses before and after training and developed a matrix of all possible combinations of responses. I then counted the frequency of response for each possible combination. I identified how many Soldiers had the same response pre- and post-training versus how many changed their responses. For those cases where Soldiers changed their responses, I performed a chi-square test to determine if any response pattern occurred significantly more often than the others.

For question 15, 20 out of 35 Soldiers (57%) had similar responses pre- and post-training. Of those who changed their responses, there was no discernable pattern (χ^2 [7, N=15] = 7.93, *n.s.*). Question 16 had 24 Soldiers make the same response (67%) while 12 changed responses. The changed responses had no significant pattern for this question either (χ^2 [6, N=12] = 3.17, *n.s.*).

Questionnaire Section Four: Free Response Section

The last section had two free response questions. The first question asked for more information about task shedding the requirement to monitor FBCB2. The question asked, "If you wanted to hand-off monitoring the FBCB2 display to someone else, who would you hand it off to?" There were a number of different responses to this question, although responses tended to fall into several categories. Table 9 shows the major categories of responses and the frequencies of response in each one. As the table shows, the most popular answer to this

question before and after training was either hand it off to another crew member (in a vehicle crew) or to the commander or leader. Before training, several respondents said they didn't know who they would hand the monitoring task to. Probably the most interesting finding from this question is that after training a number of respondents said they would hand it off to a trained user. This suggests that after training Soldiers realized the need to have FBCB2 operated by trained users.

The second question in this section asked, "What feature of this FBCB2 is the most difficult to work with?" Again, there were a number of responses which tended to fall into categories. Before training most Soldiers reported they didn't know, which suggests they had little experience with the system before training, while a few reported using the touch screen in rough terrain or while wearing chemical protective gear was difficult. After training, Soldiers had a better idea of how difficult tasks were.

Table 9. *Frequencies Of Soldier Responses To Question 17, "If You Wanted To Hand-Off Monitoring The FBCB2 Display To Someone Else, Who Would You Hand It Off To?"*

Response category	Frequency	
	Pre-training	Post-training
Don't know	3	0
Another crew member	12	9
Commander/leader	10	9
An assistant	2	5
A trained user	0	4

The two most frequent response categories after training involved using overlays and working with messages and reports. Somewhat surprisingly, after training several Soldiers reported they found all features of the FBCB2 easy to use. Response frequencies for this question are summarized in Table 10.

Table 10. *Frequencies Of Soldier Responses To Question 18, "What Feature Of The FBCB2 Is The Most Difficult To Work With?"*

Response category	Frequency	
	Pre-training	Post-training
Don't know	22	2
Using the touch screen	3	1
Messages and reporting	0	5
Planning	1	2
Using overlays	2	8
No features are difficult	0	4

Discussion

As mentioned in the introduction, there were a number of objectives to this research. The first was to determine how training affected Soldiers attitudes and behaviors towards digital systems, and also how it changed their use of the systems. The second was to identify what capabilities of digital systems, in this case FBCB2, Soldiers found more or less useful. The last objective was to identify if Soldiers exhibited certain behavior patterns towards digital systems. I will discuss how this research addressed each of these objectives.

The Effect of Training

Formal training seems to have a significant and generally positive effect on Soldier attitudes and behaviors towards digitization. After training, Soldiers reported they felt they understood the system better, they were more likely to use it, and used more of the features. This supports the idea that Soldiers who understand how to use digital tools are more likely to employ them Soldiers also reported they better understood FBCB2 weaknesses after training.

There was a statistically significant difference between pre-training and post-training attitudes and behaviors. Of the five questions in section one, four of them had rankings which differed significantly from pre- to post-training. Only question one; "What do you consider the most useful planning capabilities of FBCB2" showed no significant difference. When Soldiers were asked to rank order the usefulness of FBCB2 capabilities, there was more agreement among Soldiers after training than before for each question. This suggests the training gives Soldiers a better appreciation of FBCB2 capabilities. When asked when FBCB2 was most useful, the responses "planning" and "preparation for combat" were rated significantly higher after training, so it may be that Soldiers better understood these concepts after training.

One point that could be raised is that 40 hours of computer experience alone could have affected attitudes and behaviors independent of material presented in class. While this is possible, some evidence from this research contradicts this point. Some of the questions I asked concerned topics not covered in the class material. These topics had less change, or no change, from pre- to post-training. For example, questions 15 asked about monitoring FBCB2 after crossing the LD, and question 16 asked about how Soldiers would hand-off monitoring requirements. Neither of these topics are covered in OPNET, and neither of these questions showed significant differences between the pre-test and post-test. This suggests that it is the material presented in class which changes Soldiers' attitudes and behaviors, rather than simple experience working with digital systems. Therefore, structured, formal training may have a more significant effect than unstructured experience with the system.

Soldier Ratings of Usefulness

Soldiers generally feel FBCB2 is useful, and is worth the additional effort required to employ digitization. They reported it is most useful for planning, preparation for combat, and movement, but less during combat (i.e. enemy contact). Once maneuver units are in contact with the enemy, they are focused on the enemy and typically do not have time to view digital displays. Also, once the enemy is seen, the enemy in range has higher priority than any enemy displayed on digital systems which is out of range. These phases (planning, preparation for combat, and movement) also were reported to have the highest workload. This naturally follows since those features that are used least will not have high workloads associated with them.

Soldiers ranked the most useful planning capabilities as sending and receiving messages and overlays, and route planning. The most useful non-planning related features ranked as most useful were sending and receiving messages, navigating to a location, checking the location of enemy units, and avoiding threats such as minefields. Overall, Soldiers reported that those features of FBCB2 which had the highest workload and were most difficult to work with were also those rated the most useful.

Soldiers did not agree on the accuracy of different features of FBCB2 either before or after training. Although agreement was higher after training, it was still fairly low (Kendall's W = .161 after training). This is probably because accuracy was not covered in training and Soldiers may not have had enough experience with the system to estimate accuracy.

Soldier Patterns of Behavior Towards Digitization

One of the goals of this research was to see if Soldiers exhibited behaviors towards digital systems that were similar to behaviors exhibited by people in general towards automated systems. The behaviors I was interested in were disuse or avoidance, limited use, overuse or over-reliance on automation/digitization, and expert use. The second section of the questionnaire asked questions which were designed to measure these behavior patterns.

Previous observations of Soldiers and leaders using FBCB2 for exercises showed considerable disuse behaviors. However, Soldiers in this investigation reported few disuse behaviors, and the majority reported a willingness to employ FBCB2 for the majority of combat tasks. This apparent disparity has several possible explanations. First, the Soldiers in this investigation were undergoing formal training for the digital system, whereas Soldiers in the observational research reported much of their training was informal OJT. Soldiers in formal training may have felt more committed to using digital systems since they were expending effort to learn to use the systems. Second, the Soldiers in the observational research effort were from a different unit from the Soldiers in the present investigation. The different units may have had different command emphasis on the value of digitization. Since commanders and leaders often have a significant impact on the organizational climate of a unit (Bass, 1981), different command emphasis on digitization could have been reflected in the Soldier's willingness to use digital systems in the present effort.

One question attempted to identify limited use behaviors, "I only use FBCB2 to do a few things." Although there were a fair number of agreement responses to this question before training, after training the majority of responses disagreed or strongly disagreed. This suggests these Soldiers have moved beyond limited use and are willing to employ digital systems for many combat tasks.

I also wanted to see if Soldiers exhibited overuse or over-reliance in digital systems. Two questions assessed this behavior, "I know the information I get from FBCB2 is correct," and "FBCB2 is useful to do a lot of things, but I still check to make sure the information is correct." Both of these questions dealt with cross-checking the accuracy of information from the digital system, because one of the most observable behaviors associated with over-reliance in automation is automation bias, that is, assuming the information from the automated system is correct without checking it. The answers to both of the questions indicate that Soldiers are not biased in favor of automation and they report they check the information they get from FBCB2.

The last behavior set I was interested in was expert behaviors. In fact, there is relatively little information about what constitutes general expert behavior with computer systems. Most expert behavior measures involve speed and accuracy with particular software applications, but not expert computer use in general. One behavior that is thought to indicate expertise is that experts tend to take advantage of "hot keys" and shortcuts more often than do others (Eberts, 1994), and frequently will develop their own shortcuts for tasks. Therefore, I asked Soldiers to agree or disagree with the statement, "Sometimes there are easier ways to do things on FBCB2 than what's taught in class or shown in the book." I expected that Soldiers who were more expert and tended to use shortcuts would agree with this statement.

The results showed that before training most Soldiers chose the "don't know" option, but after training there was an almost even split between agree and disagree with the statement. When the "don't know" responses are eliminated, 48% of the Soldiers agreed with the statement after training, which suggests to us that about half of the Soldiers feel comfortable enough working with FBCB2 to use shortcuts. Somewhat surprisingly, there were no correlations found between this variable and previous computer experience (or indeed any other demographic).

In general, Soldiers in this investigation did not exhibit any of the maladaptive patterns of behavior seen in other areas, nor indeed observed in other digital units. Given that this is a field effort with many extraneous variables beyond our control, it is best to be cautious in drawing conclusions. However, several of the statements which attempted to assess maladaptive behaviors showed that Soldiers' responses showed less of these behaviors after training than before. Of particular note is that Soldiers learned to take information they got from FBCB2 with caution, thus avoiding one of the major problems of automation overuse.

Teamwork Issues

An additional set of questions was asked which dealt with how Soldiers would hand-off monitoring of the digital system. The majority of Soldiers said they would hand-off monitoring requirements if they were doing something else, and they would hand it off to another crew member or their commander. The responses were fairly similar both before and after training, which may be because this topic is not covered in the classes.

Methodological Considerations

There are several caveats related to using the results of reported herein. The first is that there was a somewhat restricted range since only Soldiers E5 and above were given the questionnaires. This means the results may not be representative of the views of lower-level enlisted Soldiers.

The second consideration is that the participant group contained Soldiers who may have used digital systems (FBCB2) in different ways. Some Soldiers in the participant group belonged to maneuver units, typically platoons or companies, while others operated FBCB2 in TOCs. Soldiers in platoons and companies typically would have FBCB2 in their combat vehicles and would use them to move and engage the enemy. On the other hand, Soldiers in TOCs typically would use FBCB2 to monitor and support combat. Therefore, the way Soldiers used FBCB2 in maneuver units versus in TOCs may be significantly different. This suggests that this could have been a confounding variable which affected how Soldiers answered the questions. This could explain in part the low agreement ratings (Kendall's *W*) and multi-

modalities of some of the questions. In the future I intend to include a question asking Soldiers whether they use the digital system in a maneuver unit or in a TOC.

Future Research

It might be instructive to perform similar research on digital systems other than FBCB2 and identify similarities and differences. In addition, future research might involve a more in-depth investigation of how Soldiers employ FBCB2 functions and tools, and of its perceived utility. Another variable which might be included in future research is whether Soldiers use FBCB2 in maneuver units or TOCs. As mentioned above, Soldiers may utilize FBCB2 differently in these different environments, and an understanding of these difference may have an impact on training.

Summary of Findings and Recommendations

Formal training. Formal training seems to have a significant impact on Soldier attitudes and behaviors towards digital systems. Classes on digital systems seem to give Soldiers a positive attitude towards digital systems or reinforce a previous positive attitude. Soldiers report they better understand the system and tend to use it more and use more features. Training introduces Soldiers to features of digital systems which are useful to them that they might not otherwise learn through discovery learning or OJT. In addition, training seems to steer Soldiers away from maladaptive behavior patterns like those seen with automation in other areas. Soldiers are willing to use digital systems and tools, but at the same time avoid placing too much confidence in the system.

FBCB2 usability. Future design improvements for the FBCB2 interface should focus on improving the usability of messages and reports, and also the use of overlays. These are the functions Soldiers report they use most, and are also the most difficult to use and require the highest workload.

Summary

This research shows that formal training in digital systems has a significant positive affect on Soldiers' attitudes and behaviors towards digital systems. Not only does formal training better prepare Soldiers to use correct procedures to produce digital products, it also gives Soldiers more confidence in their ability to employ digitization. Soldiers who complete formal OPNET courses report they are more likely to use digitization and use more of the tools available. In addition, Soldiers seem to have a better appreciation of digitization's strengths and weaknesses after training.

The effort also sought to find out if Soldiers exhibited certain maladaptive behaviors towards digitization similar to those seen in other domains, such as disuse or avoidance, limited use, or overuse. I found that this sample of Soldiers exhibited few of these behaviors before training, and even less after training. In addition, I asked these Soldiers about behaviors thought to be associated with computer expertise. At the end of training, about 39% of Soldiers in this sample reported they exhibited these behaviors, although there was no correlation with previous computer experience.

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Appendix A

Acronyms

BCTC. Battle Command Training Center

BOS. Battlefield Operating System.

FBCB2. Force XXI Battle Command, Brigade and Below.

GPS. Global Positioning System.

LAN. Local Area Network.

LD. Line of Departure.

MOS. Military Occupational Specialty.

OC. Observer-Controller.

OJT. On-the-job-training.

OPNET. Operator new equipment training

PEOSTRI. Program Executive Officer, Simulation, Training, and Instrumentation.

SOP. Standard Operating Procedure.

TOC. Tactical Operations Center.

TTP. Tactics, Techniques, and Procedures.

Appendix B

Pre-Training Questionnaire

PARTICIPANT # _____ PT 60-49A

U.S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES (ARI)
Simulator Systems Research Unit, Orlando, FL

Instructions - Pre-Training Questionnaire

- DO THIS ONE FIRST – Leave the other (sealed) questionnaire in the packet (you'll do it later)
- No Names! (You will be known only by the participant number, above).
- Fill out this survey AT THE BEGINNING of the class. You will be asked to fill out another one after the class is over.
- Your participation is voluntary. You don't have to fill out the questionnaire if you don't want to.
- When you have finished, please return this questionnaire to the envelope

QUESTIONS ABOUT YOU

(A) Your Rank: _____ (B) Your MOS: _____

(C) How long have you been in the Army (total) Years _____ Months _____

(D) What digital system do you normally work with? (circle all that apply)

FBCB2 ASAS AFATDS AMDWS MCS/ (Lite) CSSCS Other _____

(E) How many months have you been using FBCB2? _____

(F) About how many hours a month do you use FBCB2? _____

(G) Have you ever taken an on-line tutorial for FBCB2? YES NO

Please continue to the next page

Section 1

- For each of the following questions, please rank order the list of items from first to last.

1. What do you consider the most useful **planning** capabilities with FBCB2? Please rank order from most useful (number 1) to least useful

_____ Plan a route

_____ Send/receive messages/plans /overlays

_____ Other _____

_____ Plan support measures

_____ Line-of-sight tools

_____ Other _____

2. What do you consider the most useful FBCB2 capabilities **other than planning**? Please rank order from most useful (number 1) to least useful

_____ Navigate to a location

_____ Avoid threats (minefields, NBC areas, etc.)

_____ Check location of subordinate units

_____ Check status of subordinate units

_____ Send/receive messages

_____ Logistics/personnel reporting

_____ Check location of enemy units

_____ Other _____

3. **When** is FBCB2 most useful to you ? Rank order from **most useful** (number 1) to **least useful**

_____ Planning

_____ Preparation for combat

_____ Attack

_____ Defense

_____ Assembly area operations

_____ Movement

_____ Actions on the objective

_____ Other _____

4. When is FBCB2 workload the highest? Rank order from **most work** (number 1) to **least work**

_____ Planning

_____ Preparation for combat

_____ Attack

_____ Defense

_____ Assembly area operations

_____ Movement

_____ Actions on the objective

_____ Other _____

5. On the FBCB2 display, which of the following is usually CLOSEST to ground truth (most accurate)? Please rank order from **most accurate** (number 1) to **least accurate**

_____ Friendly icons (center of mass)

_____ Line-of-sight analysis

_____ Terrain features

_____ Other _____

_____ Friendly icons (individual platforms)

_____ Enemy icons

_____ Overlays

Please continue to the next page

Section 2

- For each of the following statements, circle whether you **STRONGLY AGREE**, **AGREE**, **DISAGREE**, or **STRONGLY DISAGREE** with the statements, or circle **DON'T KNOW** if you're not sure.

6. "Sometimes the FBCB2 does things for no reason, or that I don't understand"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

7. "I don't use FBCB2 if I can avoid it"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

8. "FBCB2 really helps me do my job"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

9. "FBCB2 isn't worth the amount of effort I have to put into it"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

10. "I only use FBCB2 to do a few things"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

11. "I know that information I get from FBCB2 is correct"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

12. "If the FBCB2 isn't working right, it's best to try to get it working rather than revert to analog"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

Please continue to the next page

13. "FBCB2 is useful to do a lot of things, but I still check to make sure the information it gives is correct"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

14. "Sometimes there are easier ways to do things on FBCB2 than what's taught in class or shown in the book"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

Section 3

- For each of the following questions, please circle your answer.

15. How often would you look at the FBCB2 display after you crossed the Line of Departure (LD)? (Circle)
If I'm lost/confused or when approaching the next decision point Never
Every few minutes Every few seconds Other _____

16. How often would you hand-off the requirement to monitor the FBCB2 display to someone else? (circle one)
Never If I'm doing something else Every few minutes
Always Other _____

Section 4

- Please answer the questions by filling in the blank.

17. If you wanted to hand-off monitoring the FBCB2 display to someone else, who would you hand it off to?

_____

18. What feature of this FBCB2 is the most difficult to work with?

_____

You're done! Return this questionnaire to the envelope. Thanks!

Appendix C

Post-Training Questionnaire

PARTICIPANT # _____ **PT 60-49B**

U.S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES (ARI)
Simulator Systems Research Unit, Orlando, FL

Instructions - Post-Training Questionnaire

- This is the second questionnaire – you should have already completed one at the beginning of class (if you did not, tell the experimenter or instructor)

- No Names! (You will be known only by the participant number, above. Please make sure this number matches the one you filled out at the start of class).

- When you have finished, please return this questionnaire to the envelope – then turn the envelope in to the experimenter or instructor

Questions About You

(A) About how many hours a week do you use a computer at work? _____

at home? _____

(B) About how many hours a week do you play computer games? _____

(C) If you play computer games, which ones do you play (circle all that apply)

Card games	Strategy games	Arcade-type games
Role-playing games	Simulation games	Sports games
Other _____	Other _____	

Please continue to the next page

Section 1

- For each of the following questions, please rank order the list of items from first to last.

1. What do you consider the most useful **planning** capabilities with FBCB2? Please rank order from most useful (number 1) to least useful

_____ Plan a route
_____ Send/receive messages/plans /overlays
_____ Other _____
_____ Plan support measures
_____ Line-of-sight tools
_____ Other _____

2. What do you consider the most useful FBCB2 capabilities **other than planning**? Please rank order from most useful (number 1) to least useful

_____ Navigate to a location
_____ Avoid threats (minefields, NBC areas, etc.)
_____ Check location of subordinate units
_____ Check status of subordinate units
_____ Send/receive messages
_____ Logistics/personnel reporting
_____ Check location of enemy units
_____ Other _____

3. **When** is FBCB2 most useful to you ? Rank order from **most useful** (number 1) to **least useful**

_____ Planning
_____ Preparation for combat
_____ Attack
_____ Defense
_____ Assembly area operations
_____ Movement
_____ Actions on the objective
_____ Other _____

4. When is FBCB2 workload the highest? Rank order from **most work** (number 1) to **least work**

_____ Planning
_____ Preparation for combat
_____ Attack
_____ Defense
_____ Assembly area operations
_____ Movement
_____ Actions on the objective
_____ Other _____

5. On the FBCB2 display, which of the following is usually CLOSEST to ground truth (most accurate)? Please rank order from **most accurate** (number 1) to **least accurate**

_____ Friendly icons (center of mass)
_____ Line-of-sight analysis
_____ Terrain features
_____ Other _____
_____ Friendly icons (individual platforms)
_____ Enemy icons
_____ Overlays

Please continue to the next page

Section 2

- For each of the following statements, circle whether you **STRONGLY AGREE**, **AGREE**, **DISAGREE**, or **STRONGLY DISAGREE** with the statements, or circle **DON'T KNOW** if you're not sure.

6. "I'm never sure what FBCB2 will do next"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

7. "FBCB2 really helps me do my job"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

8. "I don't use FBCB2 if I can avoid it"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

9. "Digitization isn't worth the amount of effort I have to put into it"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

10. "There are only a few tasks FBCB2 is useful for"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

11. "The information on FBCB2 is almost always correct, so I don't bother checking it"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

12. "Even when it's not working perfectly, digitization is better than analog"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

Please continue to the next page

13. "As long as I check the information you get from FBCB2 to make sure it's correct, digitization is really useful"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

14. "Sometimes I make up my own shortcuts that get things done faster"

Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree

Section 3

- For each of the following questions, please circle your answer.

15. How often would you look at the FBCB2 display after you crossed the Line of Departure (LD)? (Circle)

If I'm lost/confused or when approaching the next decision point Never

Every few minutes Every few seconds Other _____

16. How often would you hand-off the requirement to monitor the FBCB2 display to someone else? (circle one)

Never If I'm doing something else Every few minutes

Always Other _____

Section 4

- Please answer the questions by filling in the blank.

17. If you wanted to hand-off monitoring the FBCB2 display to someone else, who would you hand it off to?

_____

18. What feature of FBCB2 is the most difficult to work with?

_____

You're done! Return this questionnaire to the envelope.

The purpose of this research is to find out how people learn to use digitization. This research will help us to find the best ways to train and evaluate the use of digital systems. Your participation has made this research possible **THANKS!**